

U.S. DEPARTMENT OF ENERGY  
OFFICE OF FOSSIL ENERGY  
NATIONAL ENERGY TECHNOLOGY LABORATORY



## HYDROGEN SEPARATION UTILIZING MEMBRANES

### Background

The production of hydrogen from fossil fuels, such as by coal gasification, is viewed as a pathway to a hydrogen economy based on renewables. The NETL Hydrogen Separation Group investigates, evaluates, and develops hydrogen separation membranes and materials in order to enhance hydrogen production from fossil fuels and decrease costs. Research supports technology development efforts leading to stable and robust membranes that are resistant to chemical impurities and are suitable for the rapid removal of hydrogen or carbon dioxide from various mixed gas streams. Innovations in the separation of hydrogen from the syngas produced in a gasifier, using selective membranes or membrane reactors, can increase the efficiency of the water-gas-shift reaction and consequently, significantly reduce the costs of producing hydrogen. Such membranes or membrane reactor systems will also produce a concentrated and pressurized stream of carbon dioxide suitable for sequestration.

### CONTACT

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### Goals

The goal of the Hydrogen Separation Group is to investigate, evaluate, and develop hydrogen/carbon dioxide separation technologies in order to:

- Enhance the rapid and selective production of hydrogen from fossil fuels.
- Shift the produce stream from coal gasification using novel materials that increase the efficiency of the water-gas-shift reaction.
- Provide a concentrated and pressurized stream of carbon dioxide that can be sequestered.
- Expand the knowledge base upon which researchers and developers build.
- Support technology development efforts leading to commercial applications.



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## WEBSITE

**[www.netl.doe.gov](http://www.netl.doe.gov)**

## Technical Approach

Research is conducted by the Hydrogen Separation Group in four main areas: Membrane Materials Research (develops basic material), Membrane Performance Testing (performance characterization of promising membrane materials), Water-Gas-Shift Membrane Reactor Development (evaluates the kinetics and membrane flux for enhancing the water-gas-shift reaction), and Advanced Separation Science (explores new concepts and conducts fundamental studies aimed at reducing the cost of hydrogen production, including carbon dioxide). In addition, the Hydrogen Separation Group performs membrane performance testing for external research groups from other DOE National Laboratories, universities, and industry.

This research effort includes basic studies of membrane materials, employing a state-of-the-art instrumentation (XRD, SEM, AFM, TGA, STM, XPS, AUGER, etc.). Membrane performance testing is conducted in NETL's high-pressure, high-temperature, continuous bench-scale Hydrogen Membrane Test Units at simulated industrial conditions. Performance is evaluated with regard to flux, selectivity, costs, impurity resistance, and durability. Membranes are analyzed before and after testing using a variety of surface analysis techniques.

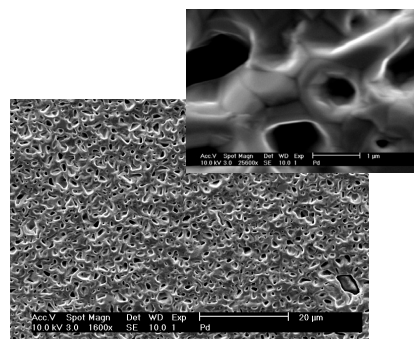
Another of NETL's Research Group, the Computational Chemistry Team, is performing a cooperative study investigating the catalytic activity, permeability, and sulfur resistance of membranes on an atomic basis.

## Benefits

Success in this project will lead to membranes that have high hydrogen flux and selectivity, are resistant to poisoning by impurities, such as sulfur compounds, and have the durability to withstand coal gasification conditions, resulting in lower costs from the production of hydrogen.



*Hydrogen membrane test unit being prepared for a membrane test*



*Photomicrographs of a sulfided palladium membrane*